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Medical Waste Water Treatment by Membrane Filtration

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***Abstract**: In this study is presented the result obtained for the treatment of waste water from the medical sector using membrane filtration system. Polyethersulfone (PES) membranes were obtained using Dimethylformamide DMF like solvent, with different concentration to determine the rejection variation of different dyes. Membranes were obtained by the immersion precipitation method and permeation properties were determined by dead end technique. The results show that the membranes filtration method can by improved to reduce the cost of the water treatment from the medical sector. Using DMF solvent membranes with a smaller concentration of polymer have a good rejection results in comparison with other membranes obtained with different solvents.*

***Keywords**: polymer, PES, membranes, water treatment*

1. Introduction

In the medical sector are many types of contaminants that have raised great concern like organic compounds, drugs, pharmaceutically active substances, etc. In general these types of pollutants have a high persistence and the concentrations of them in the sewage system are made by predictions. According to the legislation in the medical sectors is not necessary to have a waste water installation plant to remove the pollutants before water discharge. To avoid fresh water contamination treatment of wastewater at the source is necessary [1, 2]. The presence of PhACs in water (wastewater, surface and drinking water), were analyzed in the literature [3-5]. Biological water treatment and membrane bioreactors are the most used technique for water treatment to remove organic and inorganic impurities. In the last years many studies show that the antibiotics are detected in various environments, lakes, water reservoirs and ground water, and the spread of them cause pollution for the environment [6,7]. The removal of micropollutants (MPs)is a challenge for wastewater industry and membrane technology can be the solution [8-11]. The main problem in membrane process is the fouling effect, which occurs on the membrane surface due to the roughness. In the same time increase of the permeation without affecting the rejection properties is a challenge. In this studio membrane with different concentration of polymer were obtained using Dimethylformamide DMF like solvent. The polymer concentration is important for the permeation properties and in the same time influences the rejection properties. Many researchers improve the membrane properties by adding additives in the membrane structures [12-15]. Additives like ZnO, TiO_2 nanoparticles increase the porosity of the membranes and reduce the surface roughness. To obtain efficient membranes is necessary to establish the best polymer concentration for every type of solvent.

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2. Materials and methods

In this paper were obtained polymeric membranes using Dimethylformamide (Producer:Eastman) like solvent, and Polyethersulfone(PES)(Producer; Ensinger) (Figure 1).

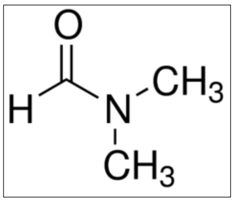

Figure 1. Dimethylformamide

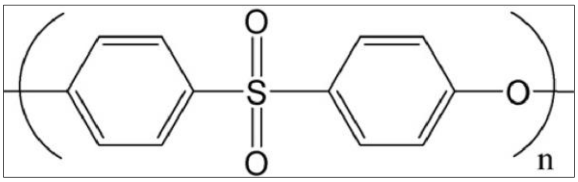

Figure 1. The structure of Dimethylformamide andPolyethersulfone

Membranes were obtained by immersion precipitation method in atmosphere with 40% air humidity. PES was dissolved in DMF and stirred for 48 hours at room temperatures. A 250 micrometer thin film of the polymeric solution was casted on a support layer and immersed in pure water for phaseinversion [11].

3. Results and discussions

3.1. Permeation properties

All obtained membranes were tested to establish the permeation properties. In Table 1 is presented the flux evolution for a membrane with 25% polymer for a volume of 80 mL pure water.

Table 1. Flux evolution

V(mL)	ΔV(mL)	min	seconds	Time (min)	Q(mL/min)	$J(L/m^2h)$
5	5	2	13	2.22	2.26	92.71
10	5	4	40	4.67	2.04	83.88
15	5	7	21	7.35	1.86	76.58
20	5	9	59	9.98	1.90	78.04
25	5	12	40	12.67	1.86	76.58
30	5	15	27	15.45	1.80	73.83
35	5	18	17	18.28	1.76	72.53
40	5	21	7	21.12	1.76	72.53
45	5	23	57	23.95	1.76	72.53
50	5	26	47	26.78	1.76	72.53
55	5	29	47	29.78	1.67	68.50
60	5	32	48	32.80	1.66	68.12
65	5	35	38	35.63	1.76	72.53
70	5	38	43	38.72	1.62	66.65
75	5	41	49	41.82	1.61	66.29
80	5	44	55	44.92	1.61	66.29

Can be observed that the membrane at 25% polymer concentration has a good stability in time. For a longer period flux still stable and the compaction rate is small, (Figure 2).

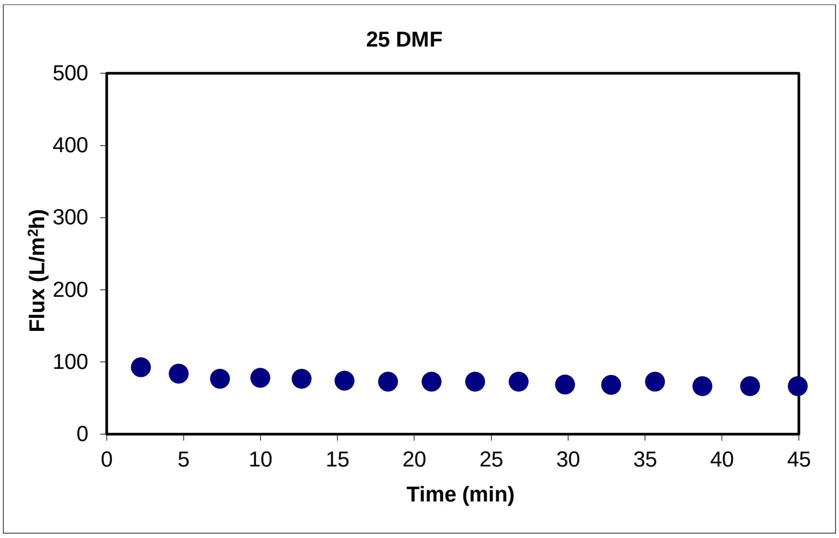

Figure 2. Pure water flux

Pure water flux is directly influenced by the polymer concentration. In figure 3 is presented the water flux at four different concentrations. Flux is decreasing from 95.5 L/m^{2}h for membranes with 19% polymer at 66.29 L/m^{2}h for membranes with 25% polymer. The effect on the water flux is due to the membranes porosity and pores size and distributions. Is effect is presented in literature for many types of membranes [16, 17].Increasing the polymer concentration the membrane porosity and the pore size decrease.

Membranes permeability, for every polymer concentration, was established by tasting membranes at four different pressures (5, 10, 15 and 20 bars), (Table 2).

Table 2. Flux evolution at different pressure

Δ*P*(bar)	Min	Seconds	Time (min)	Q(mL/min)	J(L/m^{2}h)
5	2	5	2.08	0.96	39.46
10	1	6	1.10	1.82	74.73
15	1	11	1.18	2.54	104.20
20	0	54	0.90	3.33	137.00

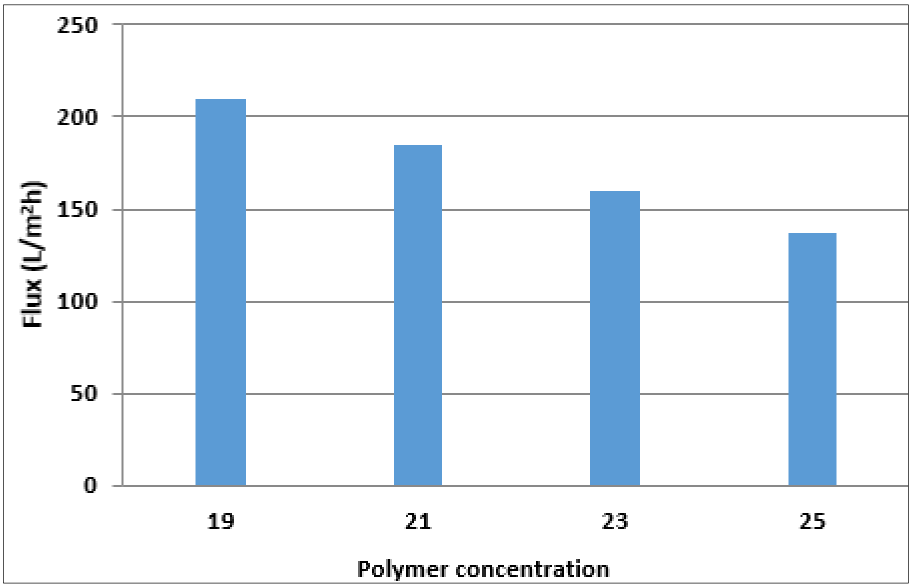

Figure 3. Pure water flux at different polymer concentration

In Figure 4 is presented the permeability for a membrane with 25% polymer. Increasing the pressure the permeability is higher but in the same time and the energy consumption is bigger increasing the treatment cost of the wastewater.

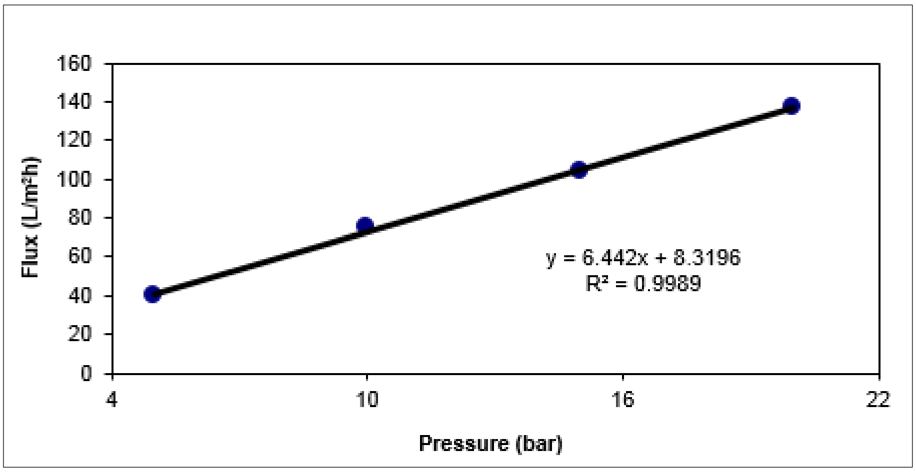

Figure 4. Pure water flux at different pressures

And the permeability is influenced by the polymer concentration being similar with the pure water flux. In Figure 5 is presented the permeability evolution at a pressure of 10 bar for membrane with different polymer concentration.

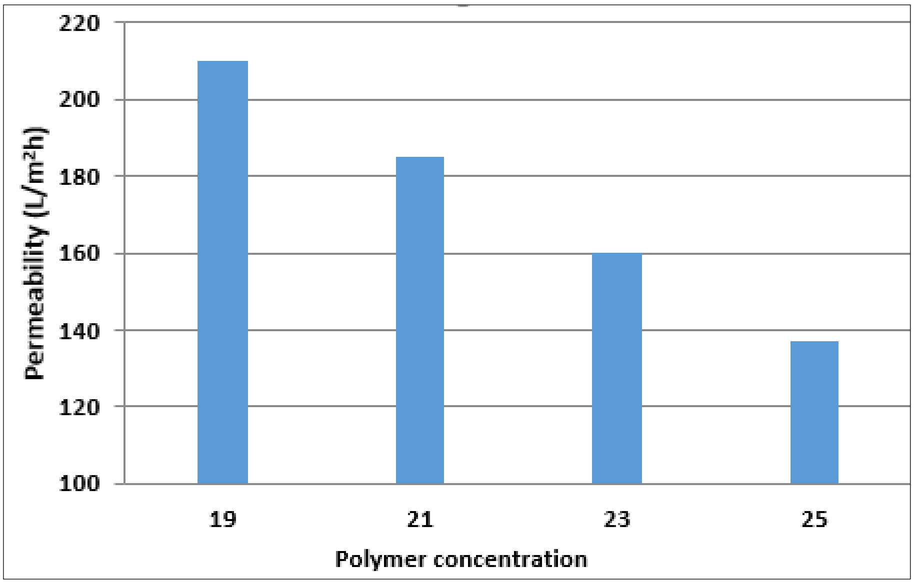

Figure 5. Permeability at different polymer concentration

The permeability properties are an important indicator for wastewater treatment process efficiency. In literatures are presented many studies regarding the use of additives to increase membrane permeability.

3.2. SEM analysis

To understand the polymer concentration on the permeation properties is necessary to see the membranes structures. Increasing the polymer concentration membrane structures is modified. Figure 7 show the structure of a membrane with 19% polymer concentration.

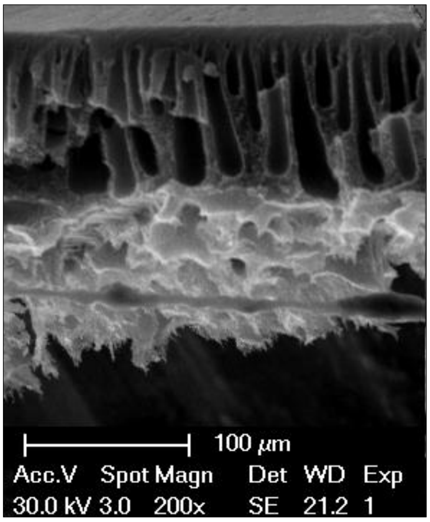

Figure 7. SEM cross section for a membrane with 19% polymer

At 19% polymer concentration the membrane structure show a thin top layer and macrovoids which connect the surface with the membrane bottom. This structure gives a good permeability to the membranes. Increasing the polymer concentration at 25%, (Figure 8), the top layer increase and the number of macrovoids are decreasing.

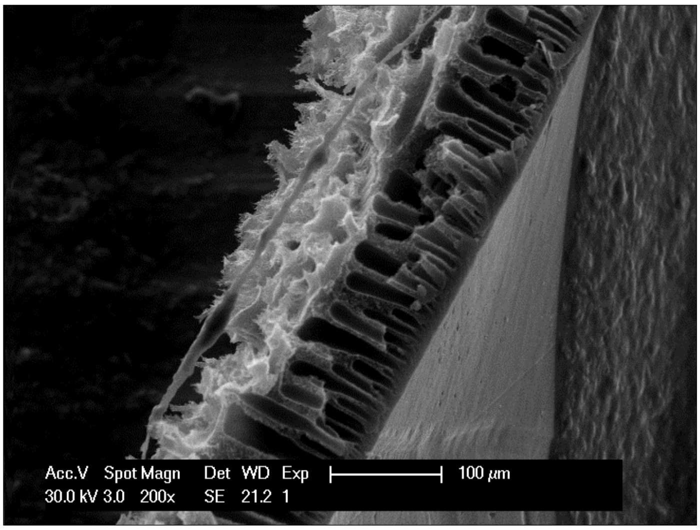

Figure 8. SEM cross section for a membrane with 25% polymer

Increasing the thickness of the top layer membranes has better rejection properties but permeation properties are decreasing.

4. Conclusions

Wastewater from the medical and pharmaceutical sectors has different types of pollutants with an important impact on the environment. Membranes technologies can be an alternative to remove MPs from wastewater before reusing or discharged.

The polymer concentration has an important impact on the water flux, increasing the polymer concentration the water permeation decreasing. The same effect is on the permeation property.

Adding additives, according to literatures, in the membranes structure the permeation properties are increasing without affecting the retention of the pollutants.

Due to the quality of environment, especially the surface and ground water, urgent actions we need to take for wastewater treatment.

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